DESCRIPTION

INFORMATION RECORDING AND REPRODUCING
APPARATUS AND A METHOD OF CONTROLLING AN INFORMATION
5   RECORDING AND REPRODUCING APPARATUS

TECHNICAL FIELD

The present invention relates to information

recording and reproducing apparatuses and, more

10   particularly, to an information recording and

reproducing apparatus which performs recording and

reproduction of information on a recordable or

rewritable recording medium having a plurality of

recording layers.

15

BACKGROUND ART

There is an information recording and

reproducing apparatus that performs a so-called

background formatting when, for example, formatting a

20   DVD+RW disc which is a rewritable disc. In the

background formatting, a notification of completion of

formatting is sent to a host computer at a time when

recording is performed on only a part of a lead-in area

of the DVD+RW disc, and a remaining area is recorded by

25   dummy data when there is no access request from the host

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computer. According to the background formatting, a
formatting process time is greatly reduced.

Additionally, as another feature of the
background formatting, there is an advantage that a disk
5   can be ejected in the middle of a formatting process.
At that time, in order to enable reproduction by a
conventional reproduction only apparatus, when ejecting
a disc in a middle of a formatting process, the disc is
ejected after filling an unrecorded area of a data area
10   with dummy data and recording a lead-in area and a lead-
out area. Thus, logical compatibility of the disc,
which is ejected in the middle of the formatting process,
with a DVD-ROM can be maintained.

In recent years, a dual-layer DVD+RW disc
15   (DVD+RW DL (Dual Layer) Disc), which has two recording
layers, has been developed as a disc on which a large
amount of data can be recorded. Accordingly, there has
been developed an information recording and reproducing
apparatus, which performs recording and reproduction
20   with respect to the dual-layer DVD+RW disc (for example,
refer to Japanese Laid-Open Patent Application No. 2004-
303421).

The background formatting is also used for the
dual-layer DVD+RW disc, similar to the DVD+RW disc
25   having a single recording layer. That is, a part of a

lead-in area is recorded for a request for formatting
from a host computer, and a notification of completion
of the formatting is sent to the host computer so as to
enable an access by the host computer and user data is
5   recorded from a data area of the first layer. Then,
while there is no access request from the host computer,
remaining areas from the first layer to the second layer
are recorded with dummy data. Additionally, eject of
the disc in the middle of formatting process is enabled.

10   However, when ejecting the dual-layer DVD+RW
disc in the middle of a formatting process, data is
recorded in a temporary middle zone (TMZ) immediately
after recording end position of user data of the first
layer and the data of the temporary middle zone is
15   recorded immediately after a position corresponding to
the user data recording end position in a data area of
the second layer, and the disc is ejected after filling
an unrecorded part of the data area of the second layer
with dummy data so as to maintain compatibility with a
20   DVD-ROM.

             FIG. 1 and FIG. 2 are illustrations for
explaining a process performed when ejecting a dual-
layer DVD+RW disc in the middle of a conventional
formatting process.

25   As shown in FIG. 1, after recording an initial

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zone 50 of a lead-in area, recording instructed by a

host computer is permitted. Then, if a request of

ejecting the optical disc is made when the user data 51

is recorded, data 52 of a temporary middle zone if

5   recorded from the end of the recorded position of the

user data 51 as shown in FIG. 2, and data 53 of the

temporary middle zone is recorded immediately after a

position corresponding to the above-mentioned user data

recording end position in the second layer. Then, an

10   unrecorded area 54 in the second layer is recorded with

dummy data, and, thereafter, the lead-in area 55 and the

lead-out area 56 are recorded and, then, the optical

disc is ejected.

However, in the conventional information

15   recording and reproducing apparatus, if a last recording

position of user data or a format end position of a

recording medium having a two recording layers, an area

in the second layer corresponding to the first recording

layer must be recorded with dummy data when a request of

20   ejecting the recording medium is made. Thus, there is a

problem that it takes a considerably long time until the

recording medium is ejected.

DISCLOSURE OF THE INVENTION

25   It is a general object of the present

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invention to provide improved and useful information

recording and reproducing apparatus and method in which

the above-mentioned problems are eliminate.

A more specific object of the present

5   invention is to provide information recording apparatus

and method which can reduce a time to eject a recording

medium having a plurality of recording layers in the

middle of a formatting process.

In order to achieve the above-mentioned

10   objects, there is provided according to one aspect of

the present invention   a method for recording

information to a recording medium having at least a

first recording layer and a second recording layer, the

first recording layer having a data area comprising an

15   inner side located at a radially inner region of the

recording medium and an outer side located at a radially

outer region of the recording medium and the second

recording layer comprising a data area including an

inner side located at the radially inner region of the

20   recording medium and an outer side located at the

radially outer region of the recording medium, the

method comprising: performing a first formatting process

on the data area of the second recording layer, said

first formatting process comprising formatting said data

25   area of the second recording layer in a series of

recording increments, the series of recording increments progressing from the inner side of the data area of the second recording layer to the outer side of the data area of the second recording layer, wherein within each

5   recording increment the formatting is performed along a path extending from the outer side of the data area of the second recording layer to the inner side of the data area of the second recording layer; performing a second formatting process on the data area of the first

10   recording layer once the first formatting process has been completed, the second formatting process being performed along a path extending from the inner side of the data area of the first recording layer to the outer side of the data area of the first recording layer.

15   The recording medium can be a disc-shaped optical recording medium, in which case the radially inner region of the recording medium would be located in the region of the inner periphery of the recording medium, and the radially outer region of the recording

20   medium would be located in the region of the outer periphery of the recording medium. This would also apply to other shapes of recording media.

             The first formatting process could occur when there is no request for user data to be read or

25   recording, and when there is no request for the disk to

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be ejected.

        In the above aspect, the formatting within
each recording increment the formatting is performed
along a path extending from the outer side of the data
5   area of the second recording layer to the inner side of
the data area of the second recording layer. In other
words, the direction of formatting within each recording
increment could be from the outer side of to the inner
side of the data area of the second recording layer.

10   As a result of the features of the above
aspect of the invention, the time needed to eject the
recording medium having a plurality of recording layers
can be reduced when ejecting the recording medium in the
middle of a formatting process.

15   The recording medium may adapted to be
recorded by a laser, and the first recording layer may
be the recording layer closest the laser during use. The
second layer could be the layer the next closest to the
laser in use.

20   The recording medium may be associated with an
order of recording user data for each recording layer,
and the first recording layer may be arranged to be
earlier in the recording order than the second recording
layer.

25   In some embodiments, the method further

comprises recording user data on a data area of the
first recording layer along a path extending from the
inner side of the data area of the first recording layer
to the outer side of the data area of the first
5   recording layer on receipt of a request to record user
data.

On receiving a request to record user data,
the method may comprise recording the user data in
priority to the performing the first formatting process
10 or the second formatting process.

The method may further comprise resuming the
first formatting process after recording the user data
if the first formatting process is not complete. The
method may further comprise resuming the second
15 formatting process after recording the user data if the
first formatting process is complete.

In some embodiments, the method further
comprises: recording predetermined data on the first
recording layer at a position immediately after recorded
20 user data on receipt of a request to eject the recording
medium.

In some embodiments, the method further
comprises: recording predetermined data on the second
recording layer at a corresponding radial position to
25 the predetermined data on the first recording layer.

In some embodiments, the method further comprises: recording predetermined data on the second recording layer at the bit inverted addresses to the addresses of the predetermined data on the first

5   recording layer.

On receipt of a request to eject the recording medium, if an end position of the user data on the first recording layer is further in the radially outer direction of the recording medium than an end position

10   of formatted data on the second recording layer, then the method may further comprise: performing a formatting process on the data area of the second recording layer so as to make the radial position of the end position of formatted data on the second recording layer correspond

15   to the radial position of the end position of the user data on the first recording layer.

In some embodiments, the path from the inner side of the data area on the first recording layer to the side of the data area on the first recording layer

20   corresponds to the path from the inner side of the data area on the second recording layer to the side of the data area on the second recording layer. The correspondence could be equivalent radial positions in the recording medium of points in each path. The

25   correspondence could also be that the areas along each

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path are at bit-inverted addresses. In such embodiments,
on receipt of a request to eject the recording medium,
if an end position of the user data on the first
recording layer is further along the path from the inner
5   side of the data area on the first recording layer to
the outer side of the data area on the first recording
layer than an end position of formatted data on the
second recording layer, then the method may further
comprise: performing a formatting process on the data
10   area of the second recording layer so as to make the
radial position of the end position of formatted data on
the second recording layer correspond to the radial
position of the end position of the user data on the
first recording layer. Such a formatting process could
15   make the address of the end position of formatted data
on the second recording layer be the bit inverted
address of the address of the end position of the user
data on the first recording layer.

     On receipt of a request to eject the recording
20   medium, if an end position of the recording of the user
data on the first recording layer is further in the
radially outer direction of the recording medium than an
end position of formatted data on the second recording
layer, then the method may further comprise: performing
25   a formatting process on the data area of the second

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recording layer so as to make the address of the end

position of formatted data on the second recording layer

be the bit inverted address of the address of the end

position of the user data on the first recording layer.

5   On receipt of a request to eject the recording

medium, the method may further comprise: obtaining a

last recorded position of data on said recording medium;

recording, when formatting has been completed to a

position of each recording layer corresponding to said

10   last recorded area, predetermined data at a position

immediately after said last recorded position in the

recording layer having said last recorded position and

at a position immediately after a position corresponding

to said last recorded position in each recording layer

15   in which the data is not recorded; and ejecting said

recording medium after recording the predetermined data.

          On receipt of a request to eject the recording

medium, the method may further comprise: obtaining a

last recorded position of data on said recording medium;

20   obtaining a format end position of each recording layer

in which the data is not recorded yet; recording dummy

data, when an area from said last recorded position to a

position corresponding to said format end position is an

unrecorded area with respect to one of the recording

25   layers having said last recorded position of the data in

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accordance with said last recorded position and said
format end position, the dummy data being recorded in
the area from said last recorded position to the
position corresponding to said format end position;
5   recording predetermined data at a position immediately
after the recorded dummy data in each recording layer
having said last recorded position of the data, at a
position immediately after said format end position in
the recording layer having said format end position, and
10   at a position corresponding to said format end position
in each recording layer in which data is not recorded
yet and formatting has completed; and ejecting said
recording medium after recording the predetermined data.
       The recording medium may be an optical disk.
15   According to a second aspect of the invention,
there is provided an information recording apparatus
arranged to record data on a recording medium having at
least a first recording layer and a second recording
layer, the first recording layer having a data area
20   comprising an inner side located at a radially inner
region of the recording medium and an outer side located
at a radially outer region of the recording medium and
the second recording layer comprising a data area
including an inner side located at the radially inner
25   region of the recording medium and an outer side located

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at the radially outer region of the recording medium,

the apparatus being arranged to: format the data area of

the second recording layer of the recording medium

according to a first formatting process, said first

5   formatting process comprising formatting said data area

of the second recording layer in a series of recording

increments, the series of recording increments

progressing from the inner side of the data area of the

second recording layer to the outer side of the data

10   area of the second recording layer, wherein within each

recording increment the formatting is performed along a

path extending from the outer side of the data area of

the second recording layer to the inner side of the data

area of the second recording layer; format a data area

15   of the first recording layer of the recording medium

according to a second formatting process once the first

formatting process has been completed, the second

formatting process being along a path extending from the

inner side of the data area of the first recording layer

20   to the outer side of the data area of the first

recording layer.

The apparatus may be adapted to record data to

the recording medium using a laser, wherein the first

recording layer is the recording layer closest the laser

25   during use. The second layer could be the layer the next

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closest to the laser in use.

The recording medium may be associated with an
order of recording user data for each recording layer,
and the first recording layer may be arranged to be
5   earlier in the recording order than the second recording
layer.

The apparatus may be further arranged to
record user data on a data area of the first recording
layer along a path extending from the inner side of the
10   data area of the first recording layer to the outer side
of the data area of the first recording layer on receipt
of a request to record user data.

On receipt of a request to record user data,
the apparatus may be further arranged to record the user
15   data in priority to the performing the first formatting
process.

The apparatus may be further arranged to
resume performing the first formatting process after
recording the user data if the first formatting process
20   is not complete.

In some embodiments, the apparatus is further
arranged to resume performing the second formatting
process after recording the user data if the first
formatting process is complete.

25   The apparatus may be further arranged to

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record predetermined data on the first recording layer
at a position immediately after recorded user data on
receipt of a request to eject the recording medium.

5   The apparatus may be further arranged to
record predetermined data on the second recording layer
at a corresponding radial position to the predetermined
data on the first recording layer.

The apparatus may be further arranged to
record predetermined data on the second recording layer
10   at the bit inverted addresses to the addresses of the
predetermined data on the first recording layer.

On receipt of a request to eject the recording
medium, if an end position of the recording of the user
data on the first recording layer is further in the
15   radially outer direction of the recording medium than an
end position of formatted data on the second recording
layer, then the apparatus is further arranged to:

format the data area of the second recording layer
so as to make the radial position of the end position of
20   formatted data on the second recording layer correspond
to the radial position of the end position of the user
data on the first recording layer.

On receipt of a request to eject the recording
medium, if an end position of the recording of the user
25   data on the first recording layer is further in the

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radially outer direction of the recording medium than an

end position of formatted data on the second recording

layer, then the apparatus is further arranged to: format

the data area of the second recording layer so as to

5   make the address of the end position of formatted data

on the second recording layer be the bit inverted

address to the address of the end position of the user

data on the first recording layer.

On receipt of a request to eject the recording

10   medium, the apparatus may be adapted to: obtain a last

recorded position of data on said recording medium;

record, when formatting has been completed to a position

of each recording layer corresponding to said last

recorded area, predetermined data at a position

15   immediately after said last recorded position in the

recording layer having said last recorded position and

at a position immediately after a position corresponding

to said last recorded position in each recording layer

in which the data is not recorded; and eject said

20   recording medium after recording the predetermined data.

On receipt of a request to eject the recording

medium, the apparatus may be adapted to: obtain a last

recorded position of data on said recording medium;

obtain a format end position of each recording layer in

25   which the data is not recorded yet; record dummy data,

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when an area from said last recorded position to a

position corresponding to said format end position is an

unrecorded area with respect to one of the recording

layers having said last recorded position of the data in

5   accordance with said last recorded position and said

format end position, the dummy data being recorded in

the area from said last recorded position to the

position corresponding to said format end position;

record predetermined data at a position immediately

10   after the recorded dummy data in each recording layer

having said last recorded position of the data, at a

position immediately after said format end position in

the recording layer having said format end position, and

at a position corresponding to said format end position

15   in each recording layer in which data is not recorded

yet and formatting has completed; and eject said

recording medium after recording the predetermined data.

The recording medium may be an optical disk.

According to a third aspect of the invention,

20   there is provided an information recording and

reproducing apparatus configured and arranged to record

data on and reproduce data from each of a plurality of

recording layers of a recording medium, comprising: a

controller that controls a formatting process to format

25   said recording medium by starting from one of the

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recording layers of which recording order of data is
latest and progressing the formatting from one of the
recording layers of which the recording order is later
toward one of the recording layers of which the
5   recording order is earlier.

In the information recording and reproducing
apparatus according to the present invention the
recording medium may be an optical disc, and the
controller may control to start the formatting process
10   of each of the recording layers from an inner side of
said optical disc.

In the information recording and reproducing
apparatus according to the present invention, the
controller may control an eject process to eject the
15   recording medium from the information recording and
reproducing apparatus so as to obtain a last recorded
position of data on the recording medium when an
instruction of ejecting said recording medium is made;
record, when formatting has been completed to a position
20   of each recording layer corresponding to the last
recorded area, predetermined data at a position
immediately after the last recorded position in the
recording layer having the last recorded position and at
a position immediately after a position corresponding to
25   the last recorded position in each recording layer in

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which the data is not recorded; and eject the recording

medium after recording the predetermined data.

In the information recording and reproducing

apparatus according to the present invention, the

5   controller may control an eject process to eject the

recording medium from the information recording and

reproducing apparatus so as to obtain a last recorded

position of data on the recording medium when an

instruction of ejecting the recording medium is made;

10   obtain a format end position of each recording layer in

which the data is not recorded yet; record dummy data,

when an area from the last recorded position to a

position corresponding to the format end position is an

unrecorded area with respect to one of the recording

15   layers having the last recorded position of the data in

accordance with the last recorded position and the

format end position, the dummy data being recorded in

the area from the last recorded position to the position

corresponding to the format end position; record

20   predetermined data at a position immediately after the

recorded dummy data in each the recording layer having

the last recorded position of the data, at a position

immediately after the format end position in the

recording layer having the format end position, and at a

25   position corresponding to the format end position in

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each recording layer in which data is not recorded yet
and formatting has completed; and eject the recording
medium after recording the predetermined data.

          Additionally, there is provided according to
5   another aspect of the present invention an information
recording and reproducing apparatus configured and
arranged to record data on and reproduce data from each
of a plurality of recording layers of a recording medium,
comprising: formatting means for formatting said
10   recording medium by starting from one of the recording
layers of which recording order of data is latest and
progressing the formatting from one of the recording
layers of which the recording order is later toward one
of the recording layers of which the recording order is
15   earlier.

          In the information recording and reproducing
apparatus according to the above-mentioned invention,
the recording medium may be an optical disc, and the
formatting means may include means for starting the
20   formatting of each of the recording layers from an inner
side of said optical disc.

          The information recording and reproducing
apparatus according to the above-mentioned invention may
further comprise: means for obtaining a last recorded
25   position of data on the recording medium when an

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instruction of ejecting the recording medium is made;
means for recording, when formatting has been completed
to a position of each recording layer corresponding to
the last recorded area, predetermined data at a position

5   immediately after the last recorded position in the
recording layer having the last recorded position and at
a position immediately after a position corresponding to
the last recorded position in each recording layer in
which the data is not recorded; and means for ejecting

10   the recording medium after recording the predetermined
data.

The information recording and reproducing
apparatus according to the above-mentioned invention may
further comprise: means for obtaining a last recorded

15   position of data on the recording medium when an
instruction of ejecting said recording medium is made;
means for obtaining a format end position of each
recording layer in which the data is not recorded yet;
means for recording dummy data, when an area from the

20   last recorded position to a position corresponding to
the format end position is an unrecorded area with
respect to one of the recording layers having the last
recorded position of the data in accordance with the
last recorded position and the format end position, the

25   dummy data being recorded in the area from the last

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recorded position to the position corresponding to the
format end position;

       means for recording predetermined data at a
position immediately after the recorded dummy data in
5   each the recording layer having the last recorded
position of the data, at a position immediately after
the format end position in the recording layer having
the format end position, and at a position corresponding
to said format end position in each recording layer in
10   which data is not recorded yet and formatting has
completed; and means for ejecting the recording medium
after recording the predetermined data.

       Further, there is provided according to
another aspect of the present invention a method of
15   controlling an information recording and reproducing
apparatus configured and arranged to record data on and
reproduce data from each of a plurality of recording
layers of a recording medium, the method comprising: a
formatting step of formatting the recording medium by
20   starting from one of the recording layers of which
recording order of data is latest and progressing the
formatting from one of the recording layers of which the
recording order is later toward one of the recording
layers of which the recording order is earlier.

25   In the method of controlling an information

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recording and reproducing apparatus according to the

present invention, the recording medium may be an

optical disc, and the formatting step may include a step

of starting the formatting of each of the recording

5   layers from an inner side of the optical disc.

The method of controlling an information

recording and reproducing apparatus according to the

present invention may further comprise: a step of

obtaining a last recorded position of data on the

10   recording medium when an instruction of ejecting the

recording medium is made; a step of recording, when

formatting has been completed to a position of each

recording layer corresponding to the last recorded area,

predetermined data at a position immediately after the

15   last recorded position in the recording layer having the

last recorded position and at a position immediately

after a position corresponding to the last recorded

position in each recording layer in which the data is

not recorded; and a step of ejecting the recording

20   medium after recording the predetermined data.

The method of controlling an information

recording and reproducing apparatus according to the

present invention may further comprise: a step of

obtaining a last recorded position of data on the

25   recording medium when an instruction of ejecting the

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recording medium is made; a step of obtaining a format
end position of each recording layer in which the data
is not recorded yet; a step of recording dummy data,
when an area from the last recorded position to a
5   position corresponding to the format end position is an
unrecorded area with respect to one of the recording
layers having the last recorded position of the data in
accordance with the last recorded position and the
format end position, the dummy data being recorded in
10   the area from the last recorded position to the position
corresponding to the format end position; a step of
recording predetermined data at a position immediately
after the recorded dummy data in each the recording
layer having the last recorded position of the data, at
15   a position immediately after the format end position in
the recording layer having the format end position, and
at a position corresponding to the format end position
in each recording layer in which data is not recorded
yet and formatting has completed; and a step of ejecting
20   the recording medium after recording the predetermined
data.

    According to the above-mentioned aspects of
the invention, a time spent on ejecting the recording
medium having a plurality of recording layers can be
25   reduced when ejecting the recording medium in the middle

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of a formatting process.

Other objects, features and advantages of the
present invention will become more apparent from the
following detailed description when read in conjunction
5   with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an illustration for explaining a
process performed when ejecting a dual-layer DVD+RW disc
10   in the middle of a conventional formatting process.

FIG. 2 is an illustration for explaining a
process performed when ejecting a dual-layer DVD+RW disc
in the middle of a conventional formatting process.

FIG. 3 is a block diagram of an information
15   recording and reproducing apparatus according to first
through fourth embodiments of the present invention.

FIG. 4 is a flowchart of a disc eject process
according to the first embodiment of the present
invention performed in the information recording and
20   reproducing apparatus shown in FIG. 3.

FIG. 5 is an illustration for explaining a
disc eject process according to the first embodiment of
the present invention performed in the information
recording and reproducing apparatus shown in FIG. 3.

25   FIG. 6 is an illustration for explaining the

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disc eject process according to the first embodiment of
the present invention performed in the information
recording and reproducing apparatus shown in FIG. 3.

    FIG. 7 is an illustration for explaining the
5   disc eject process according to the first embodiment of
the present invention performed in the information
recording and reproducing apparatus shown in FIG. 3.

    FIG. 8 is a flowchart of a disc eject process
according to the second embodiment of the present
10 invention performed in the information recording and
reproducing apparatus shown in FIG. 3.

    FIG. 9 is an illustration for explaining a
disc eject process according to the second embodiment of
the present invention performed in the information
15 recording and reproducing apparatus shown in FIG. 3.

    FIG. 10 is an illustration for explaining the
disc eject process according to the second embodiment of
the present invention in the information recording and
reproducing apparatus shown in FIG. 3.

20   FIG. 11 is a flowchart of a disc eject process
according to a third embodiment of the present invention
performed in the information recording and reproducing
apparatus shown in FIG. 3.

    FIG. 12 is an illustration for explaining a
25 disc eject process according to a third embodiment of

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the present invention performed in the information

recording and reproducing apparatus shown in FIG. 3.

FIG. 13 is an illustration for explaining the

disc eject process according to the third embodiment of

5   the present invention performed in the information

recording and reproducing apparatus shown in FIG. 3.

FIG. 14 is an illustration for explaining the

disc eject process according to the third embodiment of

the present invention performed in the information

10   recording and reproducing apparatus shown in FIG. 3.

FIG. 15 is a flowchart of a disc eject process

according to the fourth embodiment of the present

invention performed in the information recording and

reproducing apparatus shown in FIG. 3.

15   FIG. 16 is an illustration for explaining the

disc eject process according to the fourth embodiment of

the present invention performed in the information

recording and reproducing apparatus shown in FIG. 3.

20   BEST MODE FOR CARRYING OUT THE INVENTION

A description will now be given, with

reference to the drawings, of embodiments according to

the present invention.

FIG. 3 is a block diagram of an information

25   recording and reproducing apparatus according to first

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through fourth embodiments of the present invention. In

FIG. 3, an optical disc 1 is a recording medium having a

plurality of recording layers. In the embodiments, the

disc 1 is a recordable recording medium having two

5   recording layers that includes a dual-layer DVD+RW disc.

The information recording and reproducing apparatus is

an optical disc apparatus that performs recording and

reproduction with respect to the optical disc 1 having

the two recording layers.

10   A spindle motor 2 is a motor for rotating the

optical disc 1 at predetermined rotation speeds when

recording and reproducing data, respectively. A

rotation control part 3 controls rotation of the motor 2.

An optical pickup 4 is a device that emits and

15   irradiates a laser light L at a predetermined recording

power when recording data on the optical disc 1 or

reproducing data from the optical disc 1. An actuator

control part 5 controls to move the optical pickup 4

when performing focusing and tracking on the optical

20   disc 1. A signal control part 6 controls a reproduction

signal output from the optical pickup 4 and a recording

signal output to the optical pickup 4.

             A drive controller 7 is achieved by a

microcomputer comprising a CPU, a ROM, a RAM, etc. The

25   drive controller 7 controls the entire information

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recording and reproducing apparatus, and also performs a

function of means including formatting means according

to the present invention. A buffer memory 8 is a memory

used as a temporarily storage area that is used by the

5   drive controller 7 to store data. A laser drive circuit

9 drives a laser of the optical pickup 4 to emit the

laser light L. An external interface 10 is used for

transmitting/receiving commands and data to/from a host

computer 11. The host computer 11 incorporates therein

10 a control part that is realized by a microcomputer

comprising a CPU, a ROM, a RAM, etc. The host computer

11 is an information processing apparatus such as a

personal computer that controls the information

recording and reproducing apparatus.

15   (First Embodiment)

In a first embodiment of the present invention,

the drive controller 7 controls a formatting process

performed on the optical disc 1 so that the formatting

process is started from a second layer of which turn of

20 recording is last and the formatting is progressed to a

first recording layer of which turn of recording is

earlier than the first recording layer.

FIG. 4 is a flowchart of a disc eject process

according to the first embodiment of the present

25 invention performed in the information recording and

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reproducing apparatus shown in FIG. 3.

Upon receipt of a format command from the host computer 11 in step S1, the drive controller 7 records, in step S2, a zone of a lead-in area of the first

5 recording layer of the optical disc 1, and sends a notification of completion of formatting process to the host computer 1 and receives a disc access request from the host computer 1.

The drive controller 7 determines whether

10 there is a user data recording request from the host computer 1. If it is determined in step S3 that there is a user data recording request from the host computer 1, the routine proceeds to step S10 so as to records user data received from the host computer 1 from a data

15 area of the first recording layer. When the entire data area of the first recording layer has been recorded, recording is performed on a data area of the second recording layer. The data recording in the data area of the first recording layer is performed in a direction

20 from an inner side to an outer side of the optical disc 1, and the data recording in the data area of the second recording layer is performed in a direction from the outer side to the inner side of the optical disc 1. If it is determined, in step S3, that there is no user data

25 recording request, it is determined, in step S4, whether

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or not there is a disc eject request from the host
computer 1.

If it is determined, in step S4, that there is
no disc eject request from the host computer 1, the
5   routine proceeds to step S11 where it is determined
whether or not the formatting process of the data area
of the second recording layer has been completed. If it
is determined, in step S11, that the formatting process
of the data area of the second recording layer has been
10   completed, the routine proceeds to step S12. In step
S12, a formatting process of the recording area of the
first recording layer is started so as to record data in
a direction from the inner side to the outer side of the
optical disc 1, and the routine returns to step S3. If
15   it is determined in step S11 that the formatting process
of the data area of the second recording layer has not
been completed, the routine proceeds to step S13. In
step S13, a formatting process of the recording area of
the second recording layer is started so as to record
20   data in a direction from the outer side to the inner
side of the optical disc 1, and the routine returns to
step S3. On the other hand, if it is determined in step
S4 that there is a disc eject request from the host
computer 1, the routine proceeds to step S5 so as to
25   determine whether or not it is in the middle of

formatting (in background). The middle of formatting
mentioned here does not mean a state where a formatting
process is performed when a determination is made but
means a state where a formatting process has not been
5   completed over an entire data area.

If it is determined, in step S5, that it is
not in the middle of formatting, the routine proceeds to
step S8. In step S8, dummy data is recorded in an
unrecorded recording area of the data area and the lead-
10   in area and the lead-out area are recorded. Then, in
step S9, the optical disc 1 is ejected, and the process
at this time is ended. If it is determined, in step S5,
that it is in the middle of formatting, it is determined,
in step S6, whether or not it is in the middle of
15   recording of user data. The middle of recording of user
data mentioned here does not mean a state where a user
data recording is performed when a determination is made
but means a state where a user data recording process
has not been completed over an entire area which has not
20   been subjected to a formatting process among the data
areas.

If it is determined, in step S6, that it is in
the middle of the user data recording, the routine
proceeds to step S7. In step S7, data of the temporary
25   middle zone (TMZ) is recorded from the last recorded

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position of the user data. Then, in step S8, dummy data

is recorded in an unrecorded area of the data area and

the lead-in area and the lead-out area are recorded.

Then, in step S9, the optical disc 1 is ejected, and the

5   process at this time is ended.

FIGS. 5 through 7 are illustrations for

explaining a disc eject process according to the first

embodiment of the present invention performed in the

information recording and reproducing apparatus shown in

10   FIG. 3.

The optical disc 1 comprises a first recording

layer 20 and a second recording layer 21 as shown in FIG.

5. The first recording layer 20 includes a lead-in area

22, a data area 23 and a middle zone 24 arranged in that

15   order from an inner side toward an outer side of the

optical disc 1. The second recording layer 21 includes

a middle zone 25, a data area 26 and a lead-out area 27

arranged in that order from the outer side toward the

inner side of the optical disc 1. In FIG. 5, the lead-

20   in area 22 and the lead-out area 27, the data areas 26

and 23, and the middle zones 25 and 24 are located in

the same radial positions of the optical disc 1,

respectively.

That is, the start address of the lead-in area

25   22 and the end address of the lead-out area 27, and the

-34-

end address of the lead-in area 22 and the start address

of the lead-out area 27 are in the same radial position

of the optical disc 1, respectively. Similarly, the

start address of the data area 23 and the end address of

5   the data area 26, and the end address of the data area

23 and the start address of the data area 26 are in the

same radial positions, respectively. The start address

of the middle zone 24 and the end address of the middle

zone 25, and the end address of the middle zone 24 and

10. the end address of the middle zone 25 are in the same

radial positions, respectively. The above-mentioned

corresponding start addresses and end addresses are at

bit inversion values, respectively. It will be

appreciated that in an optical disc such as that shown

15   in the figures, two addresses at corresponding radial

positions on different recording layers of the disc will

be bit inverted with respect to each other. Therefore,

it will be appreciated that all references to areas on

recording areas on different layers having corresponding

20   radial positions also refer to the areas having bit-

inverted addresses.

Upon receipt of a format command from the host

computer 11 after the optical disc 1 is loaded, the

drive controller 7 records an initial zone 30 of the

25   lead-in area 22. After completion of the recording, the

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drive controller 7 sends a notification of completion of
the formatting to the host computer 11, and, then,
receives a disc access for recording or reproduction
from the host computer while performing a formatting
5   process of the data areas 23 and 26 at a time when there
is no access from the host computer 11. Upon reception
of the disc access, the drive controller 7 determines
whether or not there is a request of recording user data
from the host computer 11. If there is a request of
10   recording user data, recording of user data is performed
from the inner side toward the outer side of the data
area 23 of the first recording layer.

On the other hand, if there is no request for
recording user data, the drive controller determines
15   whether or not there is a request for ejecting the disc.
If there is no request for ejecting the disc, the drive
controller 7 determines whether or not a formatting
process of the second recording layer 21 of the optical
disc 1 has been completed with reference to a bitmap
20   recorded in the lead-in area 22. If the formatting
process of the second recording layer 21 has not been
completed yet, the drive controller 7 starts the
formatting process of the data area 26 of the second
recording layer 21 from the outer side and continues the
25   formatting process toward the inner side of the optical

-36-

disc 1.

On the other hand if the formatting process of
the second recording layer 21 has been completed, a
formatting process of the first recording layer 20 is
5   performed. Here, if user data is not recorded in the
data area 23 of the first recording layer 20, the
formatting process is started from the start address on
the inner side of the data area 23 and continues the
formatting process toward the end address on the outer
10   side of the data area 23. If the user data is recorded
in a part of the data area 23, the formatting process is
started at the last recording position of the user data
and continues the formatting process toward the end
address.

15   Then, when a request for ejecting the optical
disc 1 out of the host computer 11 is made, and if only
the area 31 of the second recording layer 21 is
formatted and the formatting is still continuing and
user data has been recorded in an area 32 of the first
20   recording layer 20 as shown in FIG. 6, the last recorded
position of the user data in the data area 23 and the
end position of the formatting in the data area 26 are
obtained so as to record data of TMZ in an area 33
immediately after the area 32 of the first recording
25   layer 20 and record data of TMZ in an area 34 in the

-37-

second recording layer 21. Further, dummy data is

recorded in an unrecorded area 35 in the second

recording layer 21, and the read-in area 22 and the

lead-out area 27 are recorded, and, thereafter, the

5   optical disc 1 is ejected. In other embodiments, only

data of TMZ in an area 33 immediately after the area 32

of the first recording layer 20 is recorded, and no data

of TMZ is recorded in the second recording layer 21.

As mentioned above, by performing the

10   formatting process of the optical disc from the second

recording layer of which recording order of user data is

later, a time spent on ejecting the optical disc, when a

request for ejecting the optical disc is made in the

middle of formatting of in the middle of recording user

15   data, can be shortened, thereby reducing a time for

ejecting the optical disc.

(Second Embodiment)

A description will be given of a second

embodiment of the present invention.

20   In the second embodiment, the drive controller

7 controls the formatting process of each of the

recording layers 20 and 21 of the optical disc 1 to be

started from the inner side. FIG. 8 is a flowchart of a

disc eject process according to the second embodiment of

25   the present invention performed in the information

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recording and reproducing apparatus shown in FIG. 3.

Upon receipt of a format command from the host computer 11 after the optical disc 1 is loaded in step S21, the drive controller 7 records, in step S22, an initial zone of the lead-in area of the first recording layer of the optical disc 1. After completion of the recording, the drive controller 7 sends a notification of completion of the formatting to the host computer 11, and, then, receives a request of accessing a disc for recording or reproduction from the host computer 11.

Then, the drive controller 7 determines, in step S23, whether or not there is a request of recording user data from the host computer 11. If there is a request of recording user data, recording of user data received from the host computer 11 is performed, in step S30, from the data area of the first recording layer 20. After the data area of the first recording layer 20 is recorded, the user data is recorded in the data area of the second recording layer 21.

On the other hand, if it is determined, in step S23, that there is no request for recording user data, the drive controller 7 determines, in step S24, whether or not there is a request for ejecting the disc. If it is determined, in step S24, that there is no request for ejecting the disc, the drive controller 7

determines, in step S31, whether or not a formatting process of the second recording layer 21 of the optical disc 1 has been completed.

If it is determined, in step S31, that the
5   formatting process of the data area of the second recording layer has been completed, the routine proceeds to step S32. In step S32, a formatting process of the recording area of the first recording layer is started so as to record data in a direction from the inner side
10   to the outer side of the optical disc 1, and the routine returns to step S23.

If it is determined in step S31 that the formatting process of the data area of the second recording layer has not been completed, the routine
15   proceeds to step S33. In step S33, a formatting process of the recording area of the second recording layer is started so as to record data in a direction from the outer side to the inner side of the optical disc 1 by a predetermined amount of data, and the routine returns to
20   step S33. The predetermined amount of data is a previously set recording unit, and the data is recorded from the outer side to the inner side by the recording unit. That is to say that in step S33, the formatting process on the recording area of the second recording
25   layer is performed in recording increments. Within each

-40-

recording increment, the formatting is performed along a
path from the outer side to the inner side of the
recording area of the second recording layer, and the
recording increments are along a path from the inner
5   side to the outer side of the recording area.

On the other hand, if it is determined in step
S24 that there is a disc eject request from the host
computer 11, the routine proceeds to step S25 so as to
determine whether or not it is in the middle of
10   formatting (in background). The middle of formatting
mentioned here does not mean a state where a formatting
process is performed when a determination is made but
means a state where a formatting process has not been
completed over an entire data area. If it is determined,
15   in step S25, that it is not in the middle of formatting,
the routine proceeds to step S28. In step S28, the
lead-in area and the lead-out area are recorded. Then,
in step S29, the optical disc 1 is ejected, and the
process at this time is ended.

20   If it is determined, in step S25, that it is
in the middle of formatting, it is determined, in step
S26, whether or not it is in the middle of recording of
user data. The middle of recording of user data
mentioned here does not mean a state where a user data
25   recording is performed when a determination is made but

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means a state where a user data recording process has

not been completed over an entire area which has not

been subjected to a formatting process among the data

areas.   If it is determined, in step S26, that it is not

5   in the middle of the user data recording, the routine

proceeds to step S28.   In step S28, the lead-in area and

the lead-out area are recorded.   Then, in step S29, the

optical disc 1 is ejected, and the process at this time

is ended.

10   If it is determined, in step S26, that it is

in the middle of the user data recording, the routine

proceeds to step S27.   In step S27, data of the

temporary middle zone (TMZ) is recorded from the last

recorded position of the user data.   Then, in step S28,

15   the lead-in area and the lead-out area are recorded.

Then, in step S29, the optical disc 1 is ejected, and

the process at this time is ended.

              FIG. 9 and FIG. 10 are illustrations for

explaining a disc eject process according to the second

20   embodiment of the present invention in the information

recording and reproducing apparatus shown in FIG. 3.   In

FIGS. 9 and 10, parts that are the same as the parts

shown in FIGS. 6 through 8 are given the same reference

numerals, and description thereof will be omitted.

25   Upon receipt of a format command from the host

computer 11 after the optical disc 1 is loaded, the
drive controller 7 records an initial zone 30 of the
lead-in area 22 as shown in FIG. 9. After completion of
the recording, the drive controller 7 sends a

5   notification of completion of the formatting to the host
computer 11, and, then, receives a disc access for
recording or reproduction from the host computer 11
while performing a formatting process of the data areas
23 and 26 at a time when there is no access from the

10   host computer 11. Upon reception of the disc access,
the drive controller 7 determines whether or not there
is a request of recording user data from the host
computer 11. If there is a request of recording user
data, recording of user data is performed from the inner

15   side toward the outer side of the data area 23 of the
first recording layer.

On the other hand, if there is no request for
recording user data, the drive controller 7 determines
whether or not there is a request for ejecting the disc.

20   If there is no request for ejecting the disc, the drive
controller 7 determines whether or not a formatting
process of the second recording layer 21 of the optical
disc 1 has been completed with reference to a bitmap
recorded in the lead-in area 22. If the formatting

25   process of the second recording layer 21 has not been

-43-

completed yet, the drive controller 7 starts the

formatting process of the data area 26 of the second

recording layer 21 sequentially in an order of an area

36 and an area of 37, which have the same amount of data,

5   from the outer side and continues the formatting process

toward the inner side of the optical disc 1. It should

be noted that the formatting process is progressed in

each of the area 36 and the area 37 in a direction from

the outer side toward the inner side.

10   On the other hand, if the formatting process

of the second recording layer 21 has been completed, a

formatting process of the first recording layer 20 is

performed in the same manner as mentioned above. Here,

if user data is not recorded in the data area 23 of the

15   first recording layer 20, the formatting process is

started from the start address on the inner side of the

data area 23 and the formatting process is progressed

toward the end address on the outer side of the data

area 23. If the user data is recorded in a part of the

20   data area 23, the formatting process is started at the

last recording position of the user data and the

formatting process is progressed toward the end address.

Then, when a request for ejecting the optical

disc 1 out of the host computer 11 is made, and if only

25   the areas 36 and 37 of the second recording layer 21 are

-44-

formatted and the formatting is still continuing and

user data has been recorded in an area 38 of the first

recording layer 20 and if the last recorded position of

the user data and the format end position are at the

5   same radial position of the optical disc as shown in FIG.

10, the last recorded position of the user data in the

data area 23 and the end position of the formatting in

the data area 26 are obtained. Then, if it is

determined that both are at the same radial position,

10   data of TMZ is recorded in an area 39 immediately after

the area 38 of the first recording layer 20 and data of

TMZ is recorded in an area 40 in the second recording

layer 21. It should be noted that the area 39 and the

area 40 are at the same radial position. It also should

15   be noted that the addresses of area 39 and the area 40

are bit-inverted with respect to each other. Then, the

read-in area 22 and the lead-out area 27 are recorded,

and, thereafter, the optical disc 1 is ejected. In

other embodiments, data of TMZ is recorded in an area 39

20   immediately after the area 38 of the first recording

layer 20, but no data of TMZ is recorded in the second

recording layer 21.

As mentioned above, since the user data is

recorded from the inner side of the first recording

25   layer, there is no need to format the entire area of the

-45-

first and second recording layers if an amount of user

data to be recorded is small, and, thereby a time until

the optical disc is ejected can be reduced.

(Third Embodiment)

5   A description will now be given of a third

embodiment of the present invention.

In the third embodiment, the drive controller

7 obtains the last recorded position of the first

recording layer of the optical disc 1 in which data has

10   been recorded when an instruction to eject the optical

disc 1 is made by the host computer 11. Then, if the

drive controller 7 determines that the formatting in the

second recording layer has been completed to a position

corresponding to the above-mentioned last recorded

15   position, the drive controller 7 controls to eject the

optical disc 1 after recording TMZ (corresponding to

predetermined data) at a position immediately after the

last recorded position in the first recording layer

which has the above-mentioned last recorded position,

20   and at a position immediately after the position

corresponding to the last recorded position in the

second recording layer in which the data has not been

recorded.

FIG. 11 is a flowchart of a disc eject process

25   according to the third embodiment of the present

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invention performed in the information recording and
reproducing apparatus shown in FIG. 3.

The drive controller 7 determines, in step S41,
whether or not there is a disc eject request issued from
5   the host computer 11. If there is no disc eject request,
the process is ended. If there is a disc eject request,
the drive controller 7 controls, in step S42, to record
TMZ in the data area of the first recording layer from
the last recorded position, and also record TMZ in the
10   second recording layer at a position corresponding to
the position where the TMZ is recorded in the first
recording layer, and record the lead-in area and the
lead-out area. In other embodiments, a TMZ only needs
to be recorded on the first recording layer, and no TMZ
15   is recorded in the second recording layer. Then, the
drive controller 7 controls, in step S43, to eject the
optical disc 1, and ends the process at this time.

FIGS. 12 through 14 are illustrations for
explaining the disc eject process according to the third
20   embodiment of the present invention performed in the
information recording and reproducing apparatus shown in
FIG. 3. In FIGS. 12 through 14, parts that are the same
as the parts shown in FIGS. 5 through 7 are given the
same reference numerals, and descriptions thereof will
25   be omitted.

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If a formatting process of the second

recording layer 21 has not been completed yet, the drive

controller 7 controls to perform the formatting process

on an area 41, an area 42 and an area 43, each of which

5   has the same predetermined capacity and arranged in that

order in the data area 26 of the second recording layer

21, sequentially from the inner side toward the outer

side as shown in FIG. 12. The areas 41, 42 and 43 are

recording increments. The direction of progressing the

10   formatting process in each of the areas 41 to 43 is from

the outer side toward the inner side.

Then, when a request of ejecting the optical

disc 1 is issued by the host computer 11, the user data

last recorded position in the data area 23 and the

15   format end position in the data area 26 are obtained if

only the areas 41 through 43 have been formatted and the

formatting of the second recording layer 21 has not been

completed yet as shown in FIG. 13, the user data is

recorded in an area 44 of the first recording layer 20,

20   the user data last recorded position and the format end

position are at different positions along a radial

direction and an area at the position corresponding to

the area 44 in the first recording layer 20 in a radial

direction has been formatted. It will be appreciated

25   that if the user data last recorded position and the

-48-

format end position are at different positions along a

radial direction, then they will not be at bit-inverted

addresses. Then, if the drive controller 7 determines

that the formatting process has been progressed to the

5   position corresponding to the area 44 in the data area

26 in accordance with the both positions, the drive

controller 7 controls to record data of TMZ in an area

45 immediately after the area 44 of the first recording

layer 20 and also record data of TMZ in an area 46 of

10   the second recording layer 21. The area 45 and the area

46 are at the same position along a radial direction of

the optical disc 1 (i.e. at bit-inverted addressed), and,

thus, the area 46 is overwritten on the formatted area.

In other embodiments, a TMZ need not be recorded in an

15   area 46 of the second recording layer 21. Then, the

lead-in area 22 and the lead-out area 27 are recorded,

and the optical disc 1 is ejected.

As mentioned above, when a request of ejecting

an optical disc is issued to the information recording

20   and reproducing apparatus, and if the format end

position of the second recording layer is on the outer

side than the user data last recorded position of the

first recording layer 1, there is no need to perform

dummy data recording from the user data last recorded

25   position of the first recording layer to the formatting

start position of the second recording layer, thereby

reducing a time to eject the optical disc.

(Fourth Embodiment)

A description will now be given of a fourth

5   embodiment of the present invention.

In the fourth embodiment, when an instruction

of ejecting the optical disc 1 is issued by the host

computer 11, the drive controller 7 obtains the last

recorded position in the first recording layer 20 of the

10 optical disc 1 in which data is recorded, and also

obtains the format end position in the second recording

layer in which data is not recorded. Then, if the drive

controller 7 determines that an area of the first

recording layer from the above-mentioned last recorded

15 position to the above-mentioned format end position is

an unrecorded area with respect to the first recording

layer having the above-mentioned last recorded position,

the drive controller 7 controls to record dummy data in

the area from the above-mentioned last recorded position

20 to the above-mentioned format end position with respect

to the first recording layer having the last recorded

position, and, record TMZ (corresponding to

predetermined data) immediately after the recorded dummy

data in the first recording layer and immediately after

25 the format end position in the second recording layer,

-50-

and, thereafter eject the optical disc 1.

FIG. 15 is a flowchart of a disc eject process according to the fourth embodiment of the present invention performed in the information recording and
5   reproducing apparatus shown in FIG. 3.

The drive controller 7 determines, in step S51, whether or not there is a disc eject request issued from the host computer 11. If there is no disc eject request, then, the process at this time is ended. If there is a
10   disc eject request, the drive controller 7 determines, in step S52, whether or not a difference between the user data last recorded position in the first recording area and the format end position in the second recording layer is equal to or greater than a predetermined value.
15   The predetermined value is preferably set to, for example, 4,400 sectors which correspond to the length of the middle zone.

If it is determined, in step S52, that the difference between the user data end recorded position
20   and the format end position is equal to or greater than the predetermined value, TMZ is recorded, in step S53, from the user data last recorded position in the data area of the first recording layer, and the lead-in area and the lead-out area are recorded. Then, the optical
25   disc 1 is ejected in step S56, and, then, the process at

-51-

this time is ended.

If it is determined, in step S52, that the
difference between the user data end recorded position
and the format end position is not equal to or greater
5   than the predetermined value (less than the
predetermined value), the routine proceeds to step S54.
In step S54, dummy data is recorded in a recording area
of a range from the user data last recorded position in
the data area of the first recording layer to a position
10 corresponding to the format end position of the data
area of the second recording layer (a position in the
first recording layer at the same position in a radial
direction as the format end position of the second
recording layer, i.e. at the bit-inverted address).
15 Then, in step S55, TMZ is recorded and the lead-in area
and the lead-out area are recorded. Thereafter, the
optical disc 1 is ejected in step S56, and the process
at this time is ended. In S55, the TMZ could be recorded
only the data area of the first recording or on the data
20 areas of both the first and second recording layers.

FIG. 16 is an illustration for explaining the
disc eject process according to the fourth embodiment of
the present invention performed in the information
recording and reproducing apparatus shown in FIG. 3. In
25 FIG. 16, parts that are the same as the parts shown in

FIGS. 12 through 14 are given the same reference

numerals, and descriptions thereof will be omitted.

The user data last recorded position in the

data area 23 and the format end position in the data

5   area 26 are obtained if only the areas 41 through 43 of

the second recording layer 21 have been formatted and

the user data is recorded in the area 44 of the first

recording layer 20 and the user data last recorded

position and the format end position are at different

10   positions along a radial direction and an area at the

position corresponding to the area 44 in the first

recording layer 20 in a radial direction has been

formatted. Then, the drive controller 7 compares the

both positions and if it is determined that an

15   unrecorded area 47 corresponding to a difference

therebetween is less than the length of the middle zone

(for example, 4,400 sectors), the drive controller 7

controls to record dummy data in the unrecorded area 47

and also records the data of TMZ in an area 48

20   immediately after the unrecorded area 47 and an are 49

immediately before the recording area 43 of the second

recording layer 21. Then, after the lead-in area 22 and

the lead-out area 27 are recorded, the optical disc 1 is

ejected.

25   On the other hand, if the derive controller 7

determines that the unrecorded area 47 is equal to or longer tan the length of the middle zone, the data of TMZ is recorded in the area immediately after the area 44 of the first recording layer 21 and the area of the

5   same position in a radial direction in the second recording layer 21, and the lead-in area 22 and the lead-out area 27 are recorded, and the optical disc 1 is ejected.

It should be noted that, in the above-

10   mentioned process, if it is determined that the length of the formatted area (areas 41 to 43) is shorter than the length of the area 44 already recorded in the data area 23 based on the user data last recorded position in the data area 23 and the format end position of the data

15   area 26, dummy data may be recorded in the unrecorded area 47 corresponding to the difference between the user data last recorded position in the data area 23 and the position in the first recording layer 20 corresponding to the format end position, and the data of TMZ is

20   recorded in the area 49 immediately before the recording area 43 of the second recording layer 21, and the lead-in area 22 and the lead-out area 27 are recorded and, thereafter, the optical disc 1 is ejected.

As mentioned above, if the format end position

25   of the second recording layer and the user data last

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recorded position of the first recording layer are not

at the same position along a radial direction of the

optical disc 1, the unrecorded area of the first

recording area is caused to be already recorded in

5   response to the formatted area of the second recording

layer. Thus, the formatted area of the second recording

layer can be recognized as an already formatted area

even after the optical disc is ejected, and, thereby,

the formatting process of the second recording layer is

10   not be wasted.

It should be noted that the data of the

temporary middle zone (TMZ) recorded when ejecting the

dual-layer DVD+RW disc in the above-mentioned

embodiments may be dummy data.

15   Additionally, although the case of the optical

disc having two recording layers was explained in the

above embodiments, the present invention is applicable

to an optical disc having more than two recording layers

in the same manner.

20   The information recording and reproducing

apparatus according to the present invention is used

with a recording medium having a plurality of recording

layers that is detachably attached thereto, and the

present invention is applicable to an apparatus that

25   performs recording and reproduction on such as recording

medium.

The present invention is not limited to the specifically disclosed embodiments, and variations and modifications may be made without departing from the

5   scope of the present invention.

The present application is based on Japanese priority application No. 2005-071456 filed March 14, 2005, the entire contents of which are hereby incorporated herein by reference.